

5-day Photo-polarimetric Observations on blazar 0716+714 -

A probe into Microvariability in blazars

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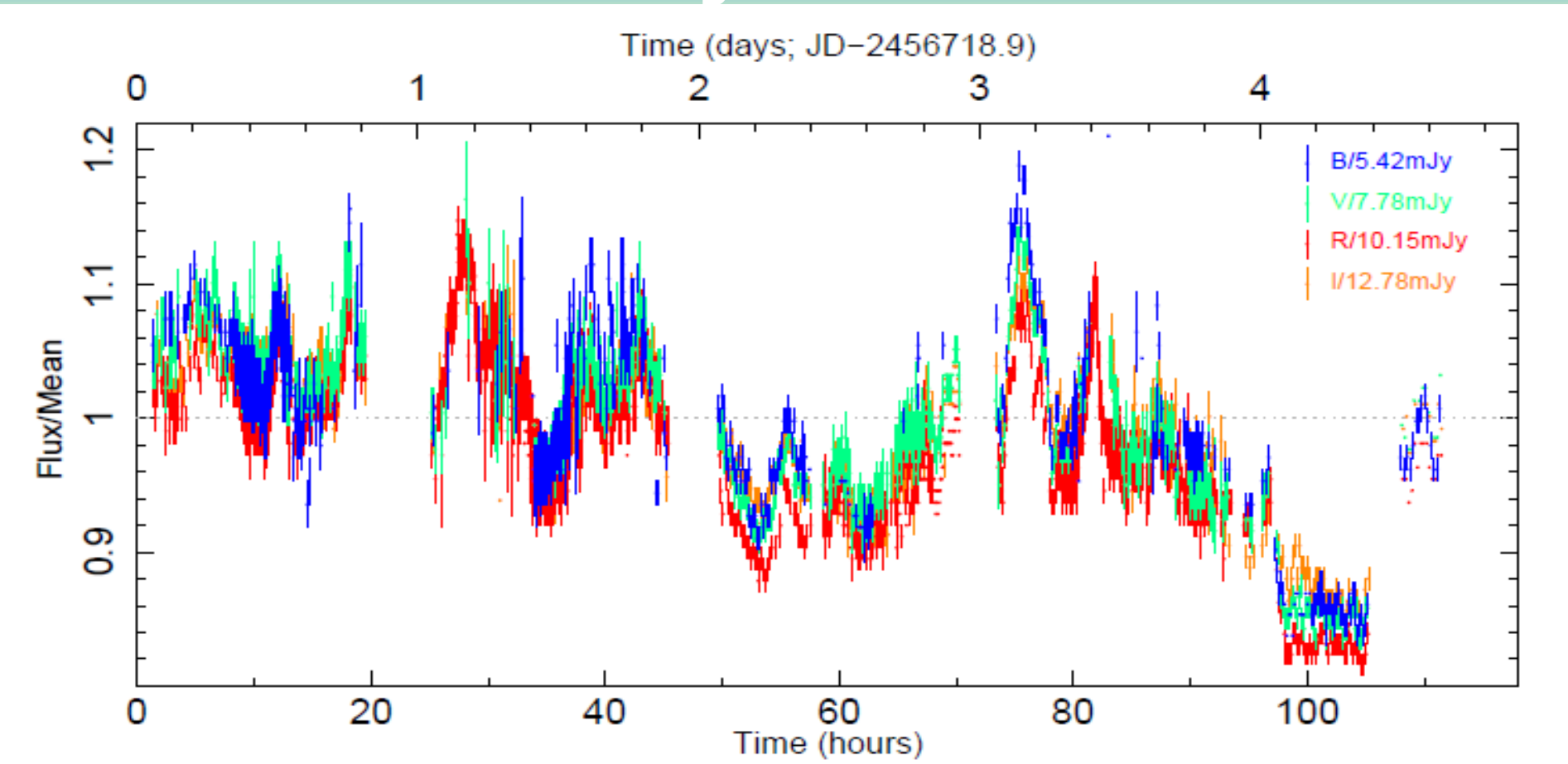
BACKGROUND

- Blazars are the most violent extra-galactic systems in the universe.
- They are characterized by broadband emission ranging from radio to gamma rays, high luminosity, high polarization and their flux variability in all studied time scales and emission frequency.
- In most cases, fast variability the emission regions in blazar are not resolvable by current instruments, therefore, study of its variability properties proves to be one of the most important tool to learn about the emission regions and thereby the blazar physics.
- Flux variability in the time scales of few minutes to 24 hrs is often known as intraday/intrnight or microvariability.
- Study of microvariability can provides us with smallest variability time scale which places constraint on a number of parameter such as size of the emission region, cooling time scales which, in turn, can be used to estimate other physical parameters such as magnetic field, particle density of the emission region.
- Blazar 0716+714 is one of the most studied blazar with a position relatively easily accessible most of the times of a year the northern hemisphere sky.
- There have been numerous study on optical variability on this source.

OBJECTIVES OF THE CURRENT CAMPAIGN AND THE STUDY

- The main objective of the current research project was to organize a multi-frequency photo-polarimetric for extended observers around the globe period of time and obtain high resolution (in minutes) and continuous observation including flux in mainly BVRI filters, polarization degree (PD) and position angle (PA).
- Characterize microvariability by studying relation among simultaneous flux, PD and PA and understand the physical mechanisms such as emission process, particle acceleration etc. involved in such short term fluctuation observed in blazars.

Flux Variability in BVRI Filters



CAMPAIGN SUMMARY

WEBT Campaign Photometric Data Summary

Filter	Number of obs.	Mean Mag.	Peak-to-peak Osc. (%)	Frac. var (%)
B	561	14.78	38	6.54 ± 0.07
V	776	14.26	35	5.74 ± 0.06
R	1921	13.79	36	5.79 ± 0.03
I	723	13.28	28	5.28 ± 0.05

WEBT Campaign Polarimetric Data Summary

Obs.	Epoch I		Epoch II	
	14 hrs	18 hrs	14 hrs	18 hrs
Flux (mag)	13.64	13.86	13.66	13.88
PD (%)	1.32	10.45	3.45	12.36
PA (deg.)	40.15	75.02	13.59	42.25

Lomb-Scargle Periodogram

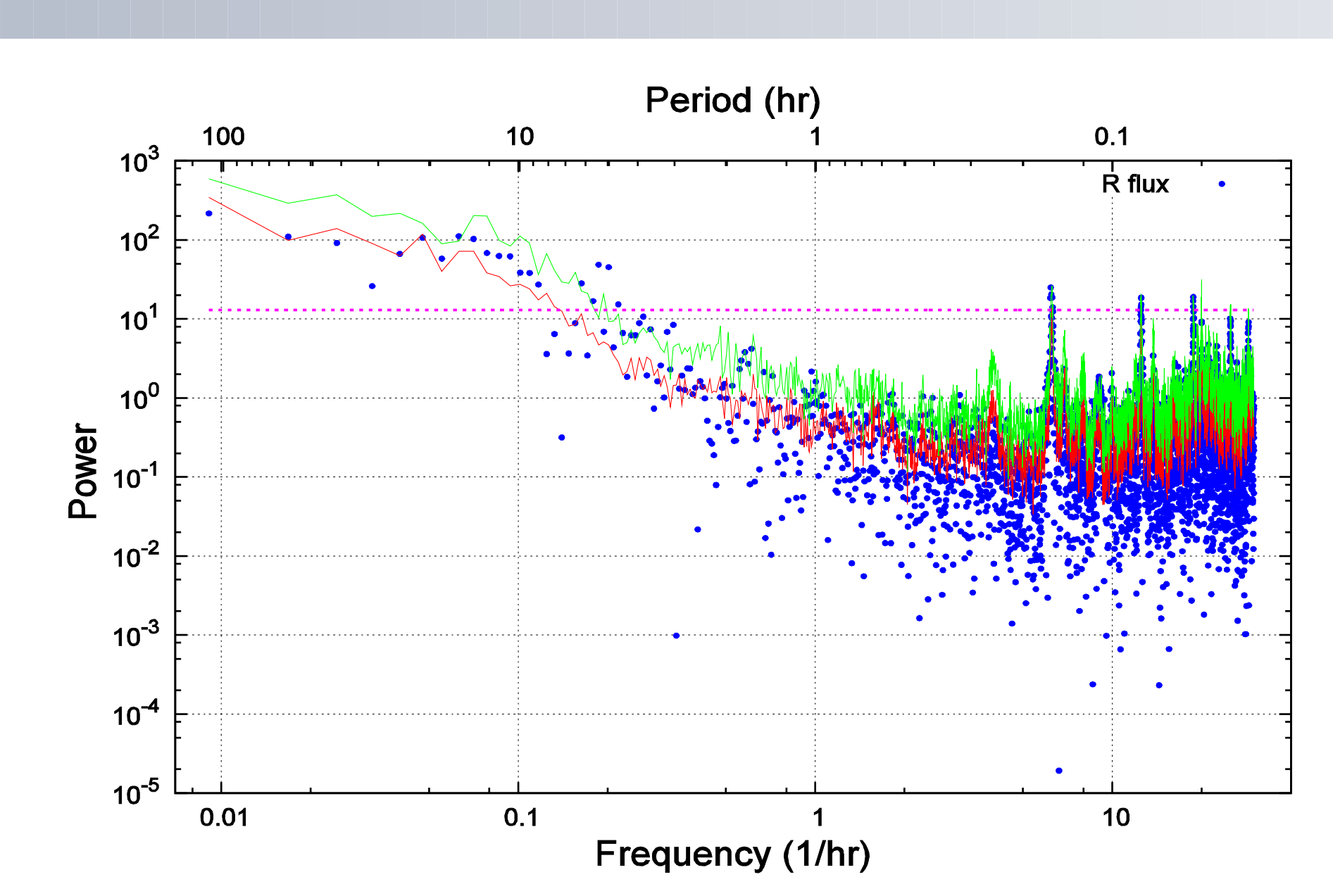
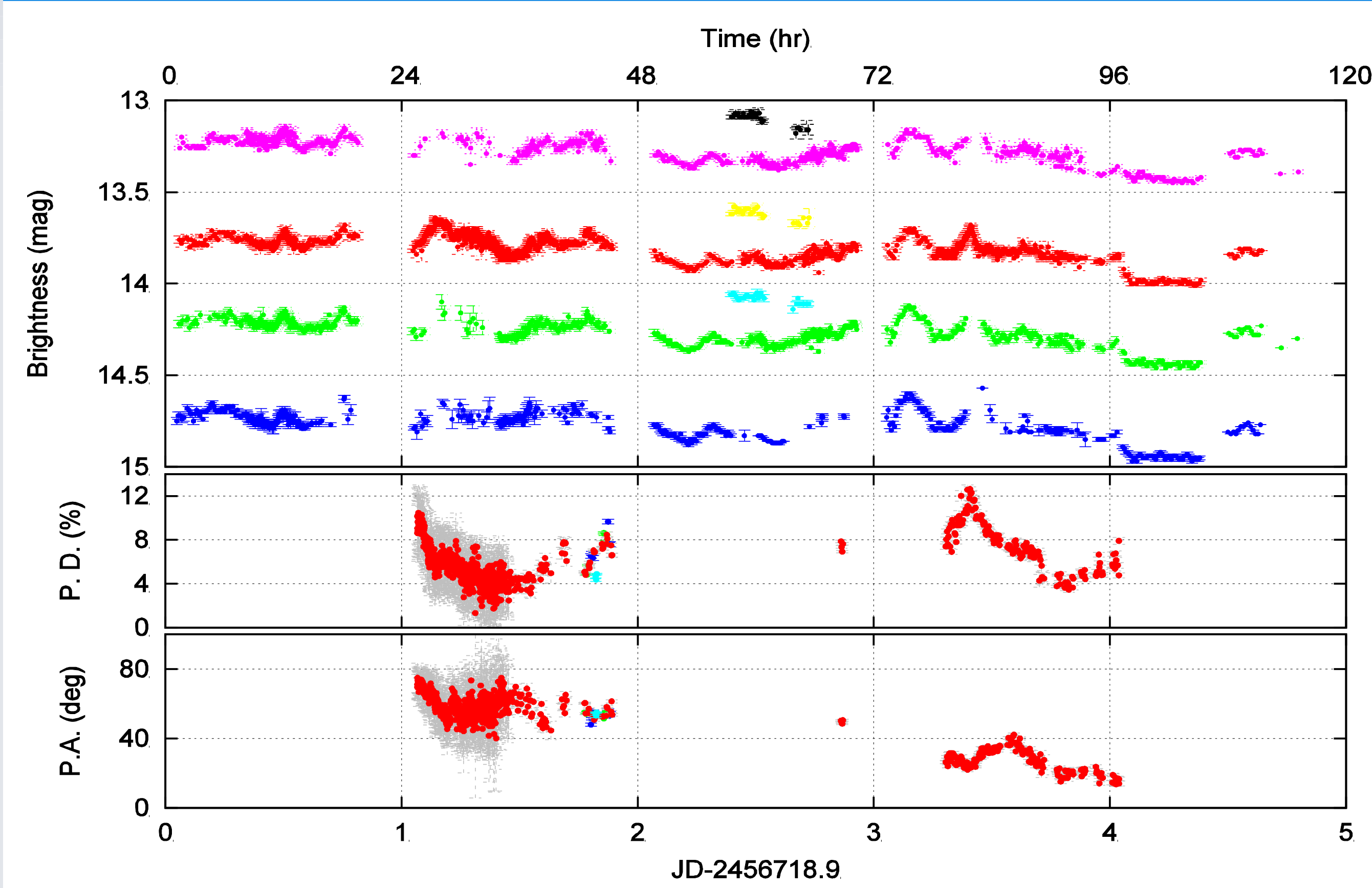
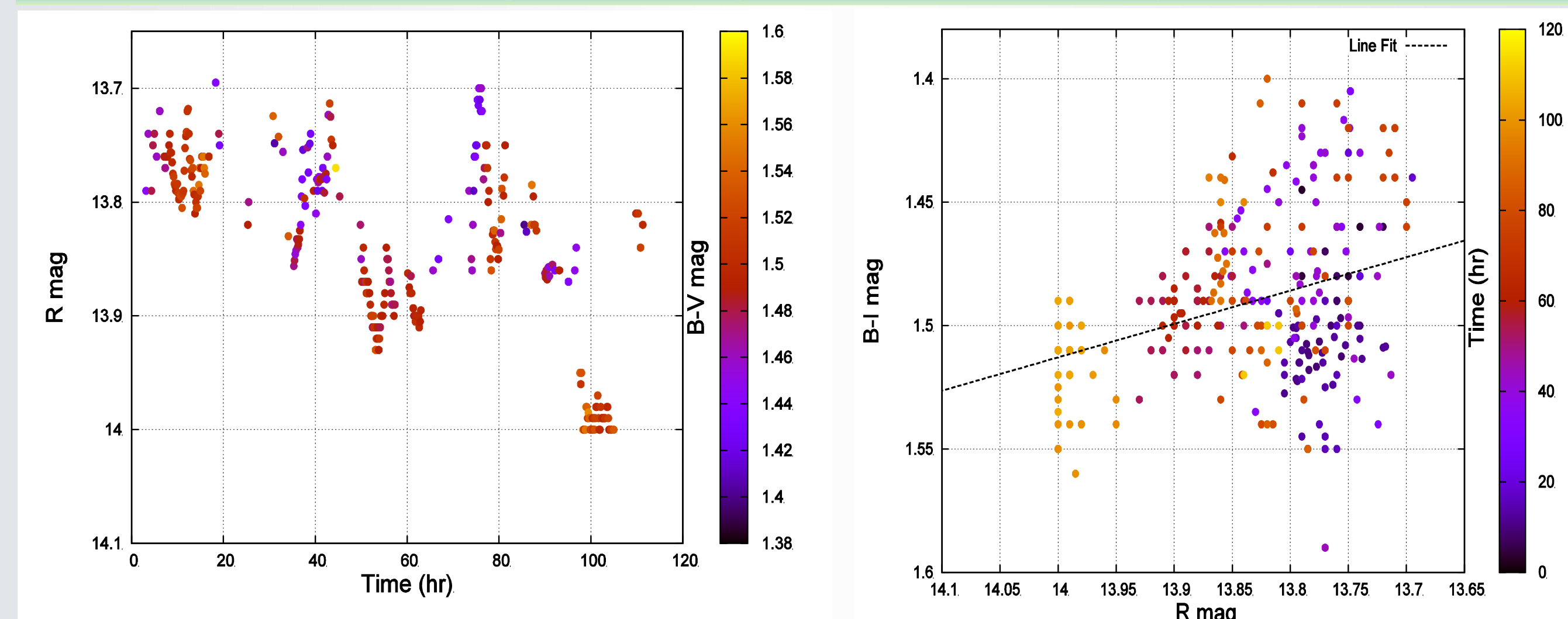


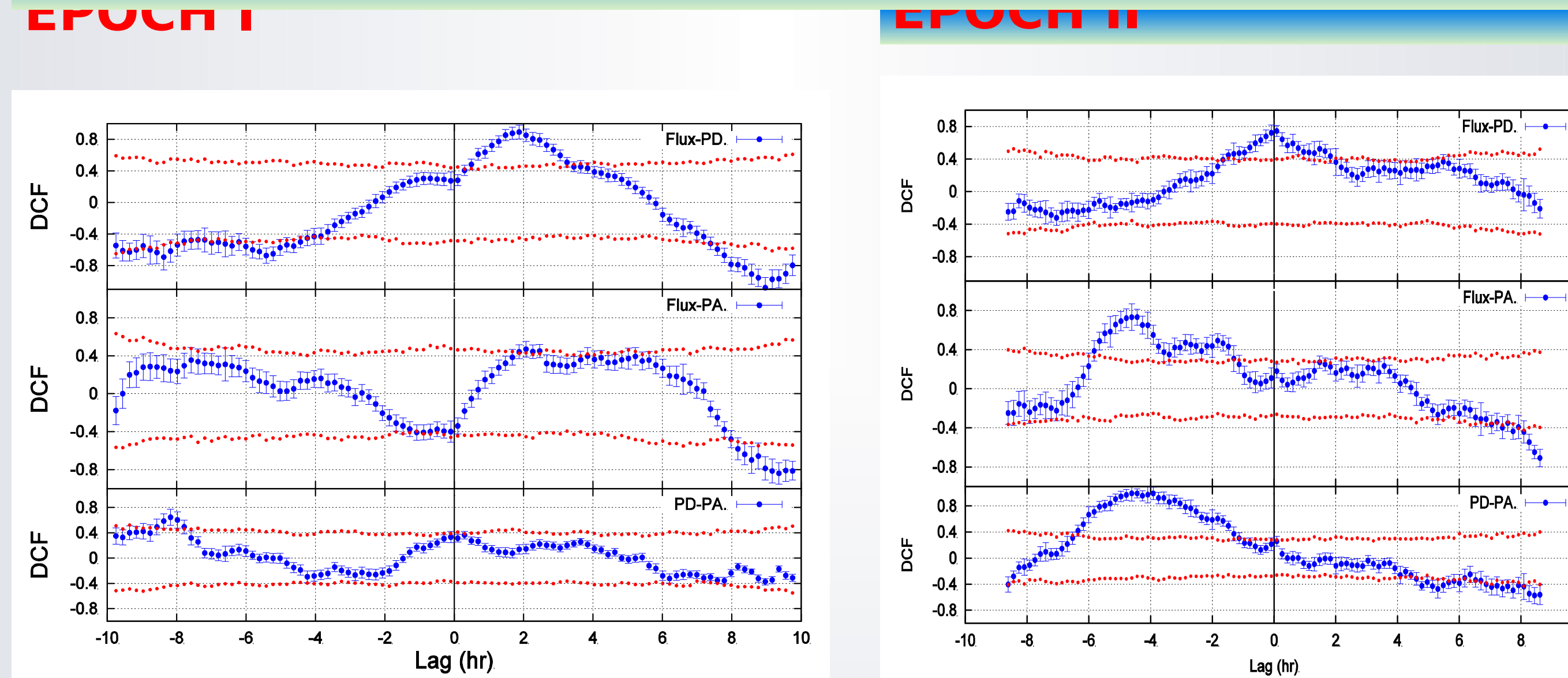
Photo-polarimetric Variability during the



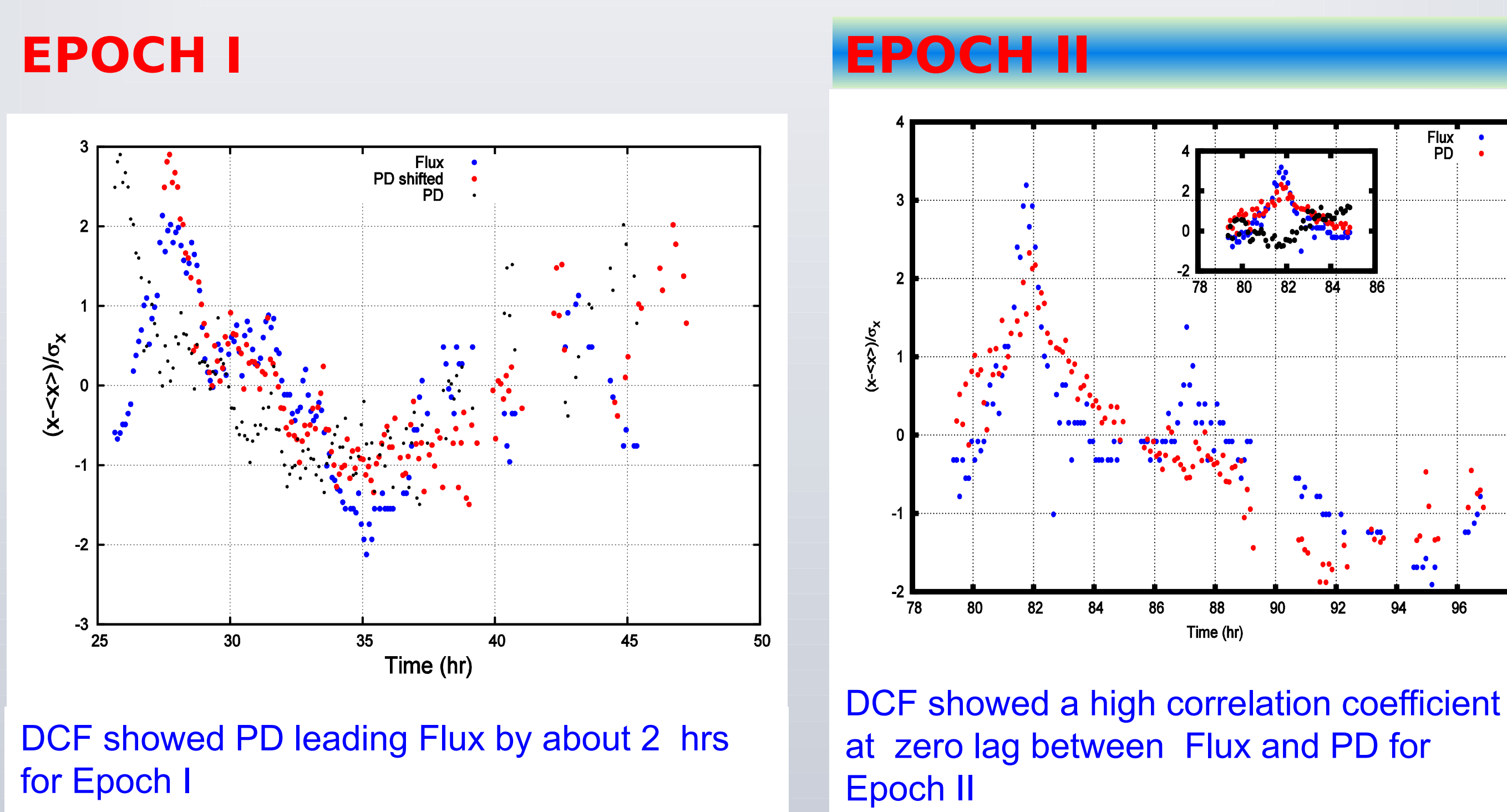
Color Variability during the Campaign



DISCRETE CORRELATION COEFFICIENT - FLUX, PD AND PA



CORRELATION BETWEEN FLUX AND POL. DEGREE



DCF showed PD leading Flux by about 2 hrs for Epoch I

DCF showed a high correlation coefficient at zero lag between Flux and PD for Epoch II

Modelling Microflares

Modeling Procedure

Assumption: A microflare observed in the light curve can be considered as composed of a flare component and a slowly varying background component.

Therefore, $F_1 = F - F_0$, $PI_1 = PI - PI_0$ and $PA_1 = PA - PA_0$

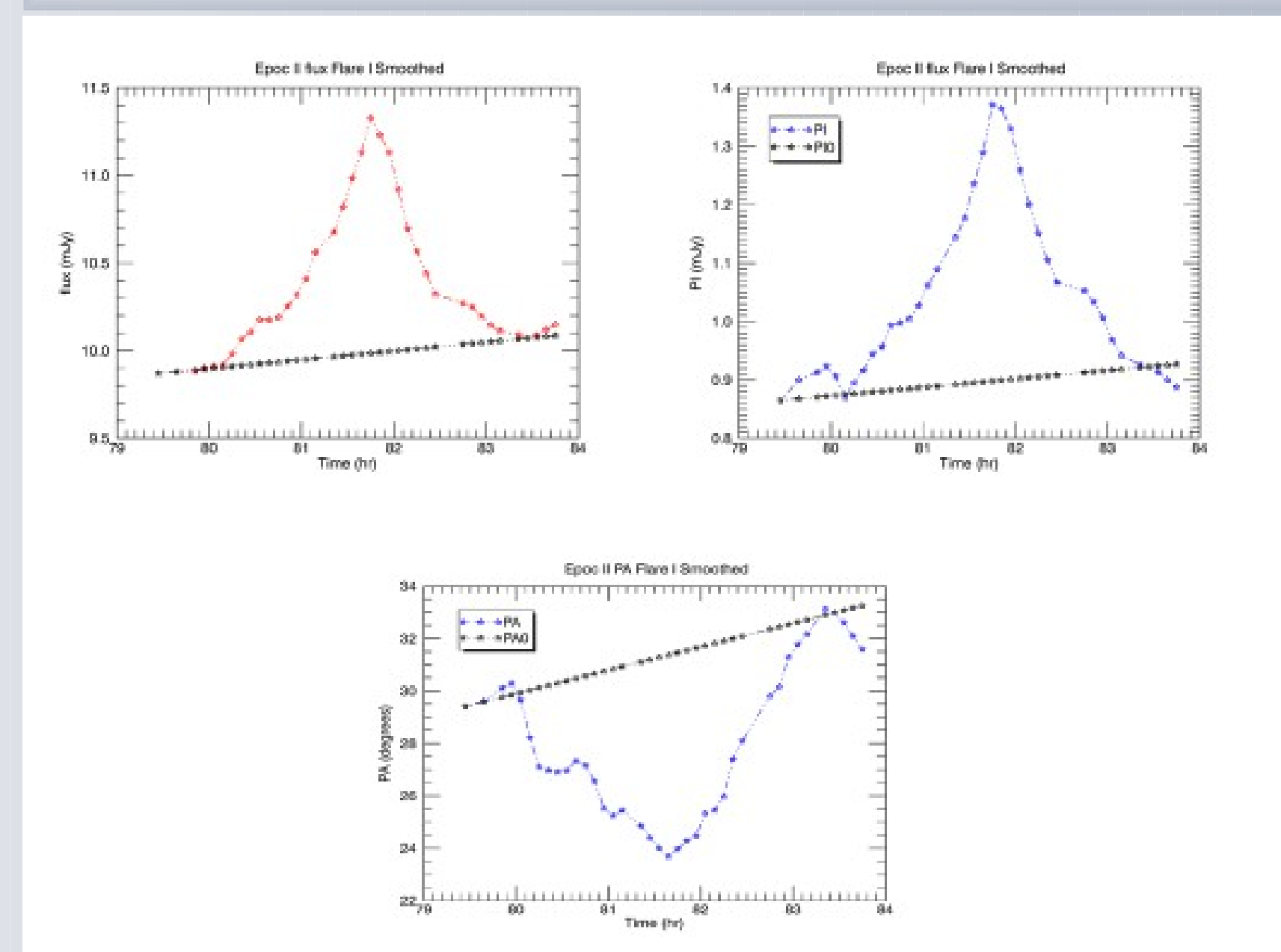
where $F \rightarrow$ flux from the light curve
 $F_0 \rightarrow$ Back ground flux from line fitting the flare
 $F_1 \rightarrow$ flare component obtained by subtracting the background

and so on for Polarization Intensity (PI) and Position Angle (PA)

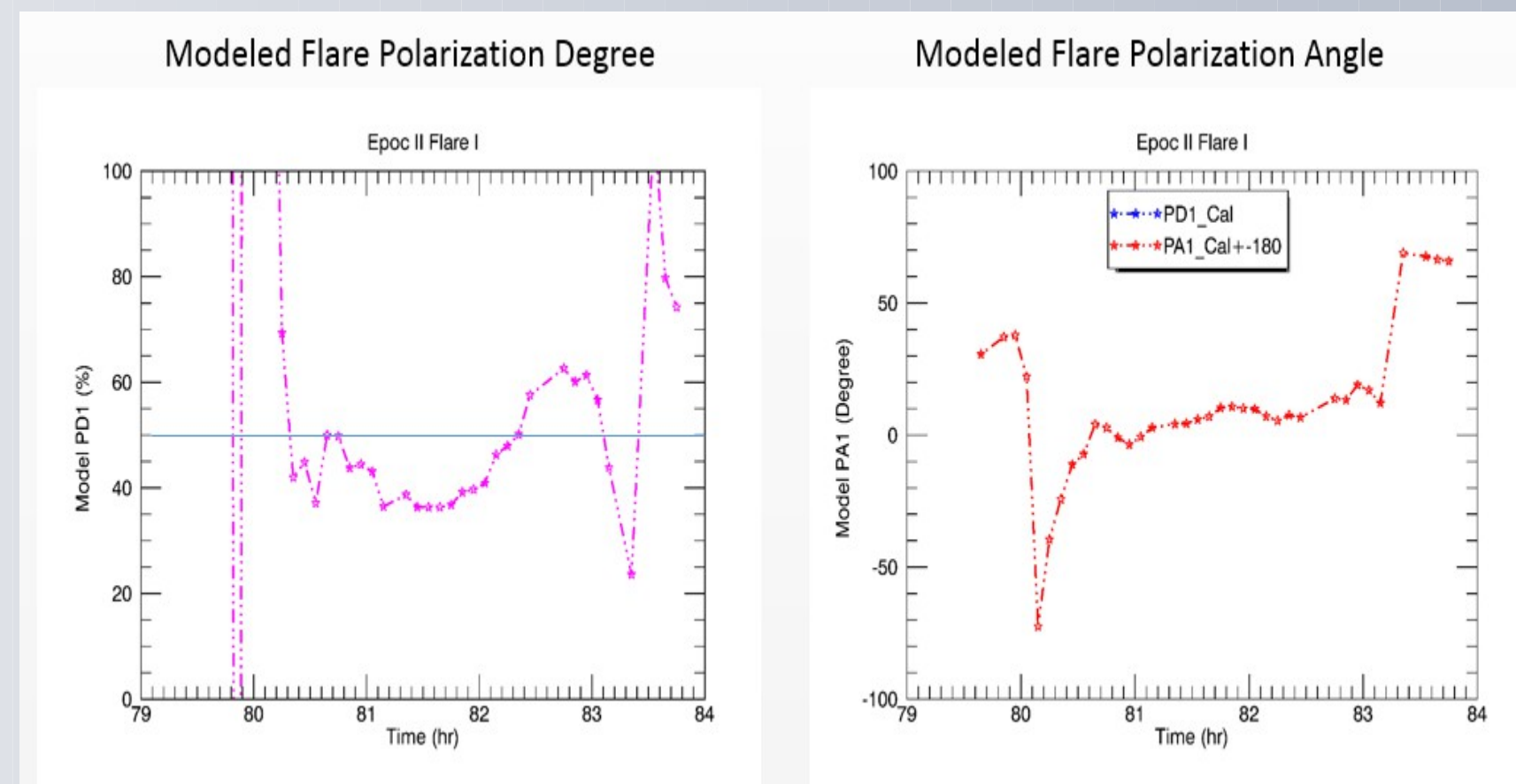
..... Calculate Model PD1 and PA1

$PI = (PI_0 \cos(PA), PI_0 \sin(PA))$
 $PI_0 = (PI_0 \cos(PA_0), PI_0 \sin(PA_0))$
 $PI_1 = PI - PI_0 = (PI_0 \cos(PA) - PI_0 \cos(PA_0), PI_0 \sin(PA) - PI_0 \sin(PA_0)) = (X, Y)$
 $PA_1 = \tan^{-1}(Y/X)$
 $|PD_1| = |PI_1|/F_1$

Microflares



Modelling PD and PA flares



Modelling Results

- The modeled polarization degree for the microflare high for the most of the part except the time around the start and the end of the microflare where the value of PD is biased by the small value of the flux.
- This suggests that the microflare mainly results from the synchrotron emission.
- The size of such regions can be approximately given as $t_{flare} * c$ - nearly 4 light hours

CONCLUSIONS

- The data presented an excellent case of microvariability in the given timescale as flux, PD and PA exhibited significant variability.
- Lomb-Scargle periodogram of the data along with simulated light curve showed a high probability of being 6 hrs time scale being significant one.
- Very weak correlation between color and flux
- Bluer-when-brighter behavior could not be claimed for the whole campaign period
- Variable correlation flux and PD was observed in two different epochs.
- No correlation between PA and either PD or flux was found.
- Similar simultaneous multi-frequency photo-polarimetric studies should be carried out in other sources as well to compare the observations in the sources and then to generalize the observed behaviors.

- To search for any time scale dueto quai-periodic oscillations, Lomb-Scargle periodogram is calculated. Since a periodogram is noisy by nature, a rigorous statistics is required to test the presence of significant frequency. The statistics by the method do not take account of the red noise like behavior found in blazar power spectrum. Besides, the gaps and unevenly sampled data present adds to the complexity by introducing spurious peaks in the periodogram in the form of aliases and spectral leakage.
- Light curves are simulated using a model power law obtained by fitting the periodogram and then they are used to estimate the significant of the most outlier points in the periodogram.
- A time scale of 6 hrs is found above 99% significance level.
- Similar time scale for QPO in the source is claimed by Gupta et al. 2008

Thank You